ORGANOCHLORINE CONTAMINANT DECLINES AND THEIR PRESENT GEOGRAPHIC DISTRIBUTION IN GREAT LAKES SPOTTAIL SHINERS (Notropis hudsonius)

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Ministry
of the
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ORGANOCHLORINE CONTAMINANT DECLINES

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IN GREAT LAKES SPOTTAIL SHINERS (*Notropis hudsonius*)

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PREFACE

During the past few years there has been growing concern over the increasing numbers of fish contaminants in Ontario lakes and rivers. Some contaminants may reach concentrations in fish which pose a risk for human consumption, while the health of the fish themselves does not appear to be affected. Consequently, human consumption of fish from some waters must be controlled because of their content of materials such as mercury or PCB's.

Effective major fish analyses programs have been directed toward the sport fish populations in order to develop appropriate human consumption guidelines. However, due to ageing difficulties and their wide-ranging life-style, contaminant residue data for adult fish do not shed much light on some fundamental questions regarding contaminant control, such as location of sources, trends with time and mechanisms of uptake.

To augment the adult sport fish surveys, the Toxicity Unit began in 1975 to conduct contaminant surveys of young fish. The program concentrates on young-of-the-year, or yearlings of a variety of species. Such fish can be easily aged and they represent current contaminant uptake conditions. The young fish have a limited range, so their contaminant uptake represents also a narrow range of space conditions. While the results may not be relevant to human consumption of sport fish from the same waters, they provide good scientific data for determining contaminant uptake as a function of time and geographic location.

This concept is being applied to investigate a number of areas of concern in the Province. The young fish surveys are supported by a variety of chemical and biological collections to suit the specific purpose of the investigation.

This report presents recent observations in organochlorine contaminant residue trends from the lower Great Lakes and the present geographic distribution of contaminant residues in young-of-the-year spottail shiners.

SUMMARY

Theresults of nearshore fish contaminant surveillance have demonstrated that significant (ρ <0.05) organochlorine residue reductions have occurred in young-of-the-year spottail shiners (Notropis hudsonius) of the Lower Great Lakes. Since the earliest fish collections in 1975, PCB residue declines ranged from 22%-89% and ΣDDT from 26%-89%. Reductions of mirex residues were also evident, but were not quantifiable.

These ΣDDT, PCB and Mirex residue reductions in fish suggest that contaminant inputs to the Great Lakes are being effectively reduced by the control measures imposed.

While residue declines were evident, PCB residues in the 1979 collections of young-of-the-year spottail shiners exceeded the proposed I.J.C.Wildlife Protection Guideline 1977 (100 ng/g) at 43% of all the sites sampled. None of the other organochlorine compounds analyzed approached this I.J.C. objective.

Chlordane levels were generally higher in fish collections from urbanized watersheds than those from agricultural regions. These observations may suggest continued chlordane use for commercial and general household applications.

Residue levels for HCB, BHC, lindane, heptachlor, aldrin, dieldrin, thiodan and endrin were low in all the spottail shiners analyzed. Generally fish residues for these chemicals have remained near their detection limits.

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INTRODUCTION

Although fish contaminant monitoring programs have been operational for over a decade in the Great Lakes, there is little published data on fish residue trends for the Lower Great Lakes. A program specifically designed to monitor trends of hazardous substances in herring gull eggs of the international boundary waters has been widely quoted for overall trend assessment in the Great Lakes Basin. Recent observations of organochlorine residue declines in the Great Lakes herring gull eggs have been identified with a general improvement of herring gull reproduction (Peakall et al. 1980; Weseloh et al. 1979). However, studies dealing with fish contaminant impact assessment continue to identify potential human health hazards associated with existing contaminantion in some of the Great Lakes fishes (Sonstegard and Leatherland 1979; Moccia et al. 1978).

In order to obtain contaminant uptake data that can be identified with specific watersheds or waste discharges, a nearshore fish contaminants surveillance program was initiated by the Ontario Ministry of the Environment in 1975. The intent of the program was to utilize young-of-the-year spottail shiners (Notropis hudsonius) as biological integrators of contaminants for problem area identification and the development of a data base for temporal trend assessment. Since residue accumulations in juvenile fishes reflect the most recent changes in contaminant regimes, nearshore young-of-the-year spottails were considered to be good indicators of hazardous substance loadings to the Great Lakes.

This report presents recent observations in organochlorine contaminant residue trends from the Lower Great Lakes and the present regional distribution of contaminant residues in young-of-the-year spottail shiners.

METHODS

Study Area

Fish collection sites used for contaminant trend determinations and their present geographic distribution are identified in figures 1A and 1B. While the 1979 collections included sites on Lake Superior, Georgian Bay, Lake Huron, St. Clair, Erie, Ontario and the St. Lawrence River, the data base for trend evaluations is limited to lakes St. Clair, Erie and Ontario. Detailed descriptions of the collection sites are presented in Appendix 1.

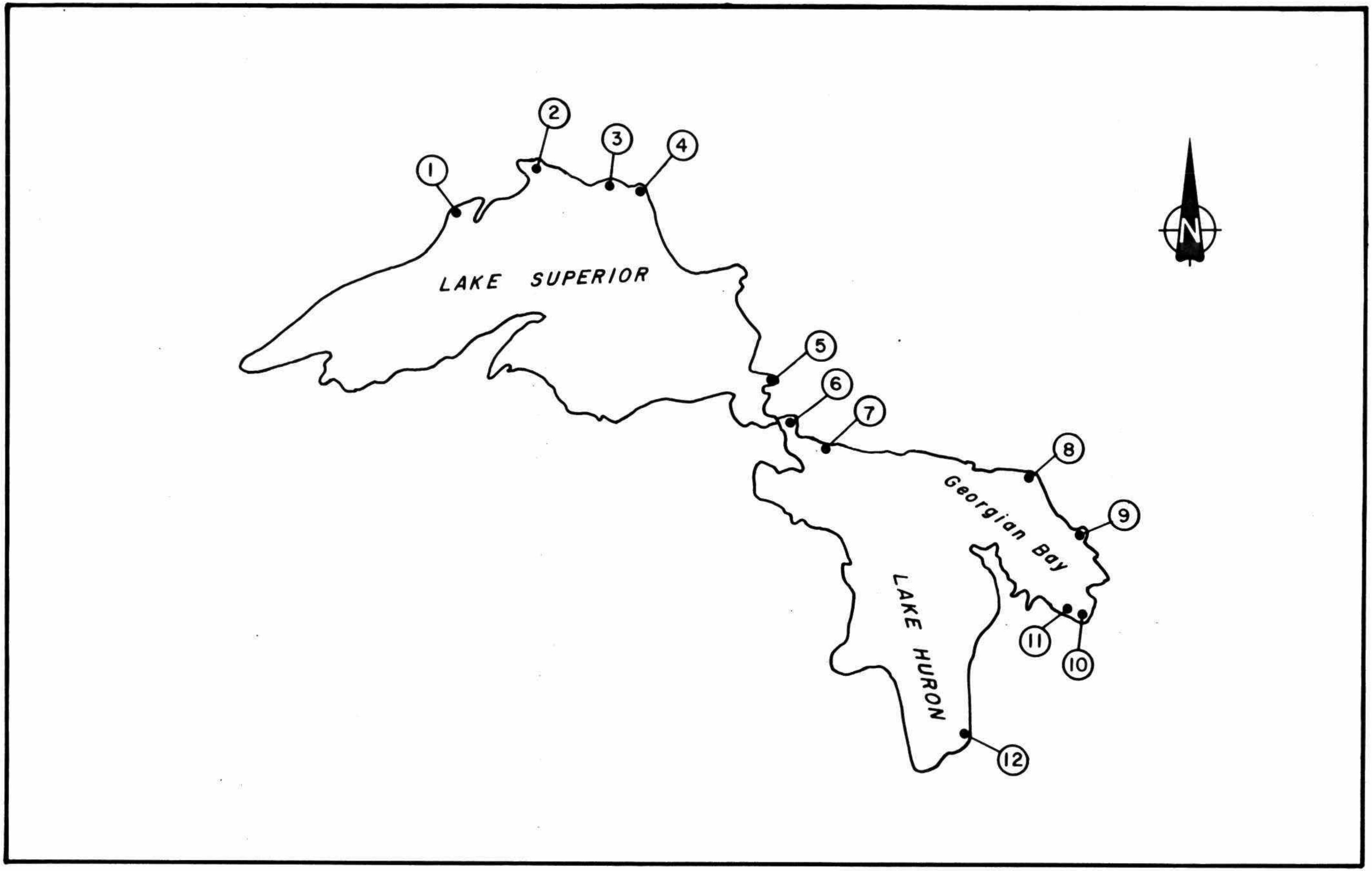

FIGURE 1a: SPOTTAIL SHINER COLLECTION SITES ON LAKE SUPERIOR, GEORGIAN BAY AND LAKE HURON

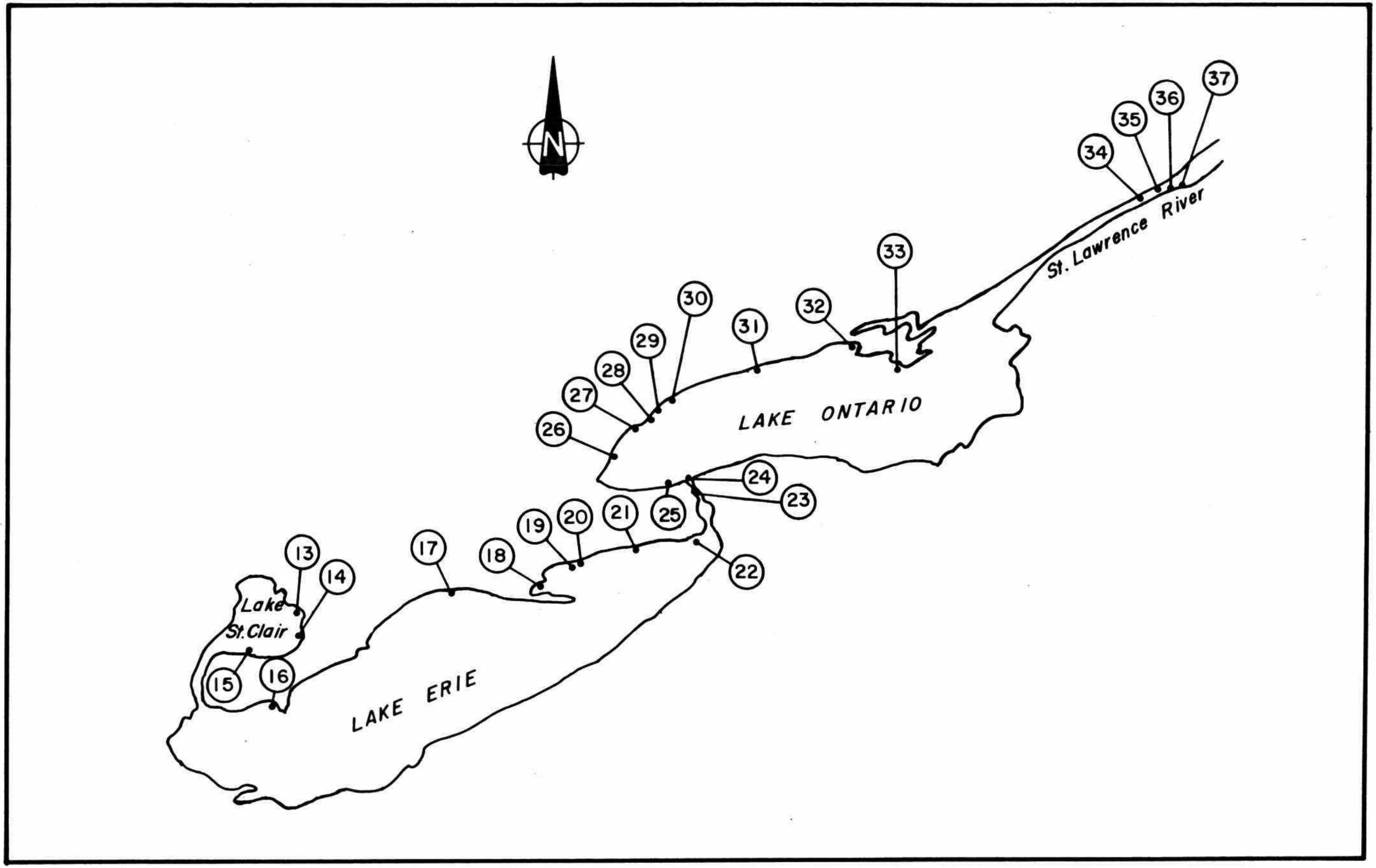

FIGURE 1b: SPOTTAIL SHINER COLLECTION SITES ON LAKES ST. CLAIR, ERIE, ONTARIO AND THE ST. LAWRENCE RIVER

Fish Collections and Analyses

Fish were collected with a 20 metre, 0.6 cm mesh bag-seine in the nearshore zones of the lakes. Where collection sites were associated with specific watershed discharges, fish samples were obtained within the affected area to measure the impact of stream or river loadings on the biota. In order to minimize contaminant uptake variations related to seasonality and the length of exposure, fish collections in succeeding years were made to coincide with previous year's sampling dates. Most of the annual collections were completed during the month of September, therefore, it càn be concluded that the majority of the fish analyzed were 3 to 4 months old. Individual fish were measured, wrapped in hexane-rinsed aluminum foil as ten fish composites and frozen in the field. Scale samples were taken from representative size groups for age determinations. Samples were stored at -20°C for about 60 days before processing for analyses.

Identification and quantification of the contaminants were done at the Ontario Ministry of the Environment Laboratory in Rexdale. PCB, HCB, BHC, lindane, heptachlor, aldrin, dieldrin, thiodan, endrin, chlordane, DDT and fish lipid contents were determined for whole fish homogenates. Details of the analytical methods are available from the Handbook of Analytical Methods for Environmental Samples, Laboratory Services Branch, Ontario Ministry of the Environment.

RESULTS AND DISCUSSIONS

Contaminant residue concentrations in young-of-the-year spottail shiners for several of the principal organochlorines have declined since the earliest Lower Great Lakes collections in 1975 (Suns and Rees, 1978). These contaminant residue declines were found to be site-specific and statistically significant ($\rho < 0.05$; t-test). While these residue declines reflect on the effectiveness of input and use restrictions imposed, care should be taken to limit the observations to the specific compounds investigated.

PCBs

The most pronounced reductions in terms of absolute values were noted for PCB residues (Table 1; Fig. 2). The reductions observed at the nine sites studied ranged from 22% - 89%. While the overall downward trend was common to all sites, the reductions were site-specific and they probably reflect PCB use and control practices in individual watersheds. Trends for Point Pelee,

TABLE 1.

ORGANOCHLORINE CONTAMINANT RESIDUES IN GREAT LAKES
YOUNG-OF-THE-YEAR SPOTTAIL SHINER SAMPLES
(CONCENTRATION IN ng/g WET WEIGHT)

Sampling Site		No. of Samples N*	Total Length (mm)	% Fat	Concentration PCB	Concentration ΣDDT	Concentration Mirex	Approx. % Decline PCB	Approx. % Decline ΣDDT	Approx. % Decline Mirex
Mitchell Bay -	1978	8	54 ± 2	1.8 ± 0.2	94 ± 50	21 ± 16	TR			
L. St. Clair	1979	7	55 ± 5	1.0 ± 0.2	ND	TR	ND	89	76	-
Thames River -	1977	8	59 ± 1	1.5 ± 0.3	67 ± 18	13 ± 6	ND			
L. St. Clair	1979	4	70 ± 5	2.4 ± 0.1	23 ± 10	9 ± 5	ND	66	31	-
Point Pelee -	1975	5	63 ± 3	1.8 ± 0.2	844 ± 403	92 ± 22	NA			
L. Erie	1977	8	58 ± 4	1.6 ± 0.3	467 ± 113	133 ± 45	ND			
	1978	8	55 ± 1	1.7 ± 0.3	528 ± 55	47 ± 10	ND			
	1979	7	61 ± 4	3.4 ± 0.5	337 ± 79	18 ± 4	ND	60	80	-
Thunder Bay -	1978	8	51 ± 2	3.0 ± 0.7	157 ± 28	33 ± 12	ND			
L. Erie	1979	5	55 ± 7	1.9 ± 0.3	31 ± 12	9 ± 7	ND	80	73	-
Niagara-on-the-Lake -	1975	5	56 ± 4	2.3 ± 0.3	690 ± 195	244 ± 52	NA			
L. Ontario	1977	7	51 ± 3	2.5 ± 0.6	654 ± 170	157 ± 38	13 ± 4			
	1978	8	51 ± 1	1.9 ± 0.2	320 ± 49	99 ± 49	29 ± 8			
	1979	8	50 ± 2	2.4 ± 0.4	153 ± 23	26 ± 9	TR	78	89	>62
Twelve Mile Creek -	1978	8	51 ± 1	2.9 ± 0.4	349 ± 63	81 ± 17	20 ± 12			
L. Ontario	1979	8	51 ± 4	2.1 ± 0.4	271 ± 49	60 ± 20	ND	22	26	>75
Credit River -	1976	10	62 ± 3	NA	1315 ± 578	278 ± 66	32 ± 13			
L. Ontario	1978	8	60 ± 3	2.6 ± 0.3	590 ± 53	96 ± 12	28 ± 3			
	1979	8	56 ± 3	3.7 ± 0.6	186 ± 28	69 ± 12	ND	86	75	>84
Humber River -	1977	8	62 ± 3	7.3 ± 0.4	2218 ± 263	265 ± 32	5 ± 2			
L. Ontario	1978	8	58 ± 5	5.8 ± 0.5	2938 ± 391	440 ± 98	15 ± 4			
	1979	8	60 ± 6	4.0 ± 1.3	1223 ± 347	74 ± 12	ND	45	72	0
Presquile Bay -	1975	5	54 ± 1	2.7 ± 0.2	520 ± 91	77 ± 12	NA			
L. Ontario	1979	8	49 ± 3	3.4 ± 0.7	122 ± 22	32 ± 10	TR	77	58	-

Dete
NA - Not Analyzed
ND - Non Detectable
TR - Trace
*Each sample is a composite of 10 fish

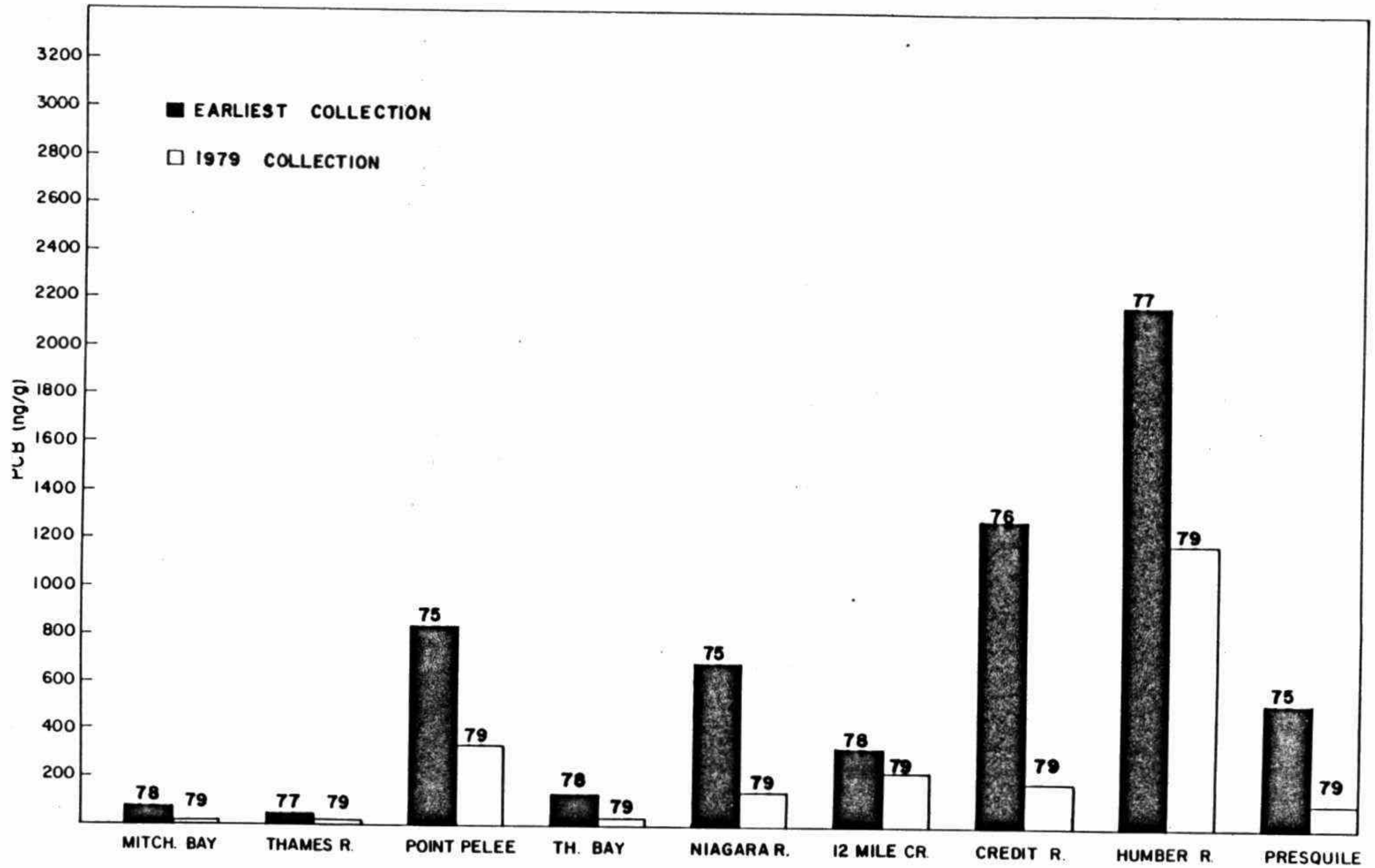

FIGURE 2. PCB RESIDUE CHANGES IN YOY SPOTTAIL SHINERS, LAKES ST. CLAIR, ERIE AND ONTARIO

Niagara-on-the-Lake, Credit River and the Humber River are shown in Fig. 3. PCB residue changes from 1977 to 1978 at Point Pelee and the Humber River did not conform to the general declines observed elsewhere. Point Pelee residue levels for the 1977 and 1978 fish collections remained essentially identical, while Humber River residues increased significantly (ρ <0.05) in 1978.

The observed PCB residue declines in nearshore juvenile spottail shiners suggest that PCB loadings to the Lower Great Lakes are being reduced by the restrictive use and discharge regulations implemented.

Although the downward trend of PCB residues in nearshore spottail shiners of the Lower Great Lakes has been substantial, the 1979 survey of 37 Great Lakes sites has shown that PCB residue concentrations in young-of-the-year spottails exceeded the suggested I.J.C. Wildlife Protection Guidelines (100 ng/g) at 43% of all sites sampled (Table 2).

DDT and Metabolites

DDT metabolite concentrations in young-of-the-year Great Lakes spottail shiners have also shown a downward trend (Table 1, Fig. 4). These results are consistent with DDT residue trends observed elsewhere (Frank et al. 1978; Beirman and Swain 1978), and appear to be related to the province-wide restrictions of the chemical in 1970. Total DDT residue reductions in nearshore spottails ranged from 26% - 89%. With the exception of the Point Pelee and Humber River sites, ΣDDT residues at other sites have decreased significantly (ρ <0.05) throughout the period sampled. Total DDT concentrations for the 1977 collection at Point Pelee remained similar to those of 1975 and a significant (ρ <0.05) increase took place at the Humber River site between 1977 and 1978. Residue trends are shown in Fig. 5. Total DDT residues in all samples analyzed were well below the suggested I.J.C. Wildlife Protection Guideline of 1000 ng/g.

Mirex (Dechlorane)

Since a portion of the mirex data were made up of residue values near their detection limits, or non-quantifiable trace concentrations, statistical evaluations were not attempted. However, mirex residue declines have been severe enough to depress residue concentrations in spottail shiners to trace and non-detectable levels for the majority of the Lake Ontario collections in 1979 (Tables 1 and 2). These mirex residue changes are consistent with

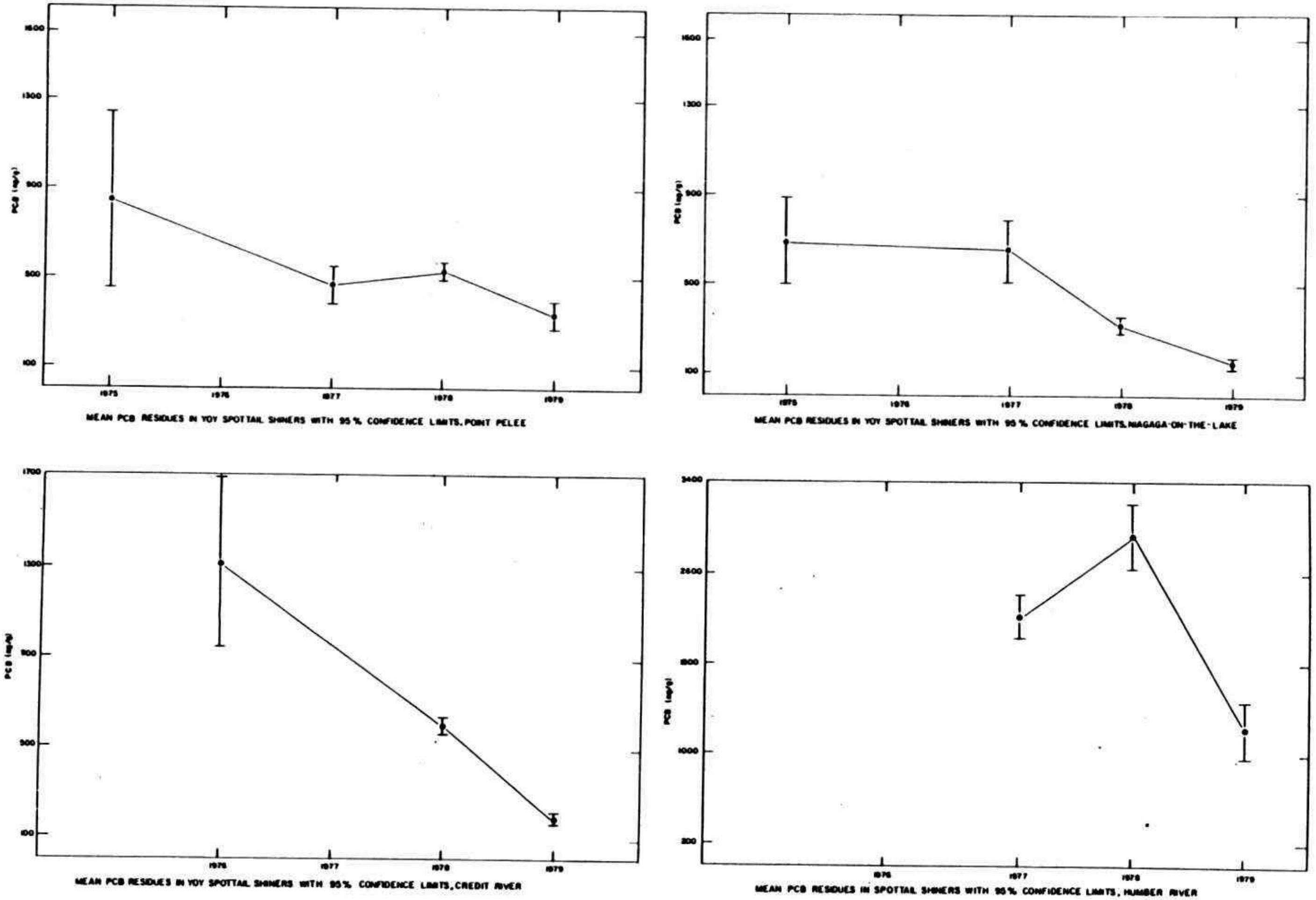

Figure 3: PCB residue trends at Point Pelee, Niagara-on-the-Lake, Credit River and Humber River.

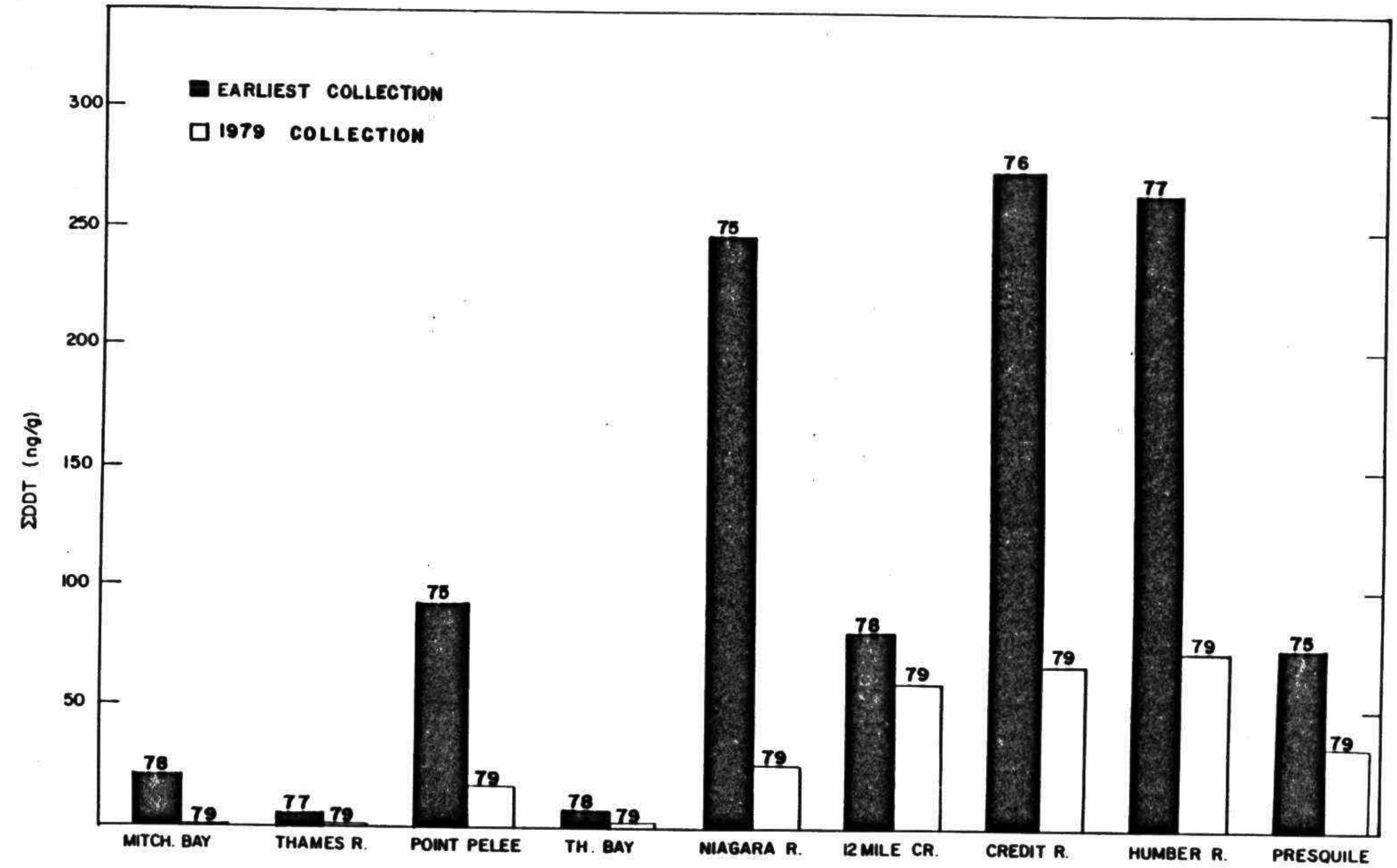

FIGURE 4. ΣDDT RESIDUE CHANGES IN YOY SPOTTAIL SHINERS, LAKES ST.CLAIR, ERIE AND ONTARIO

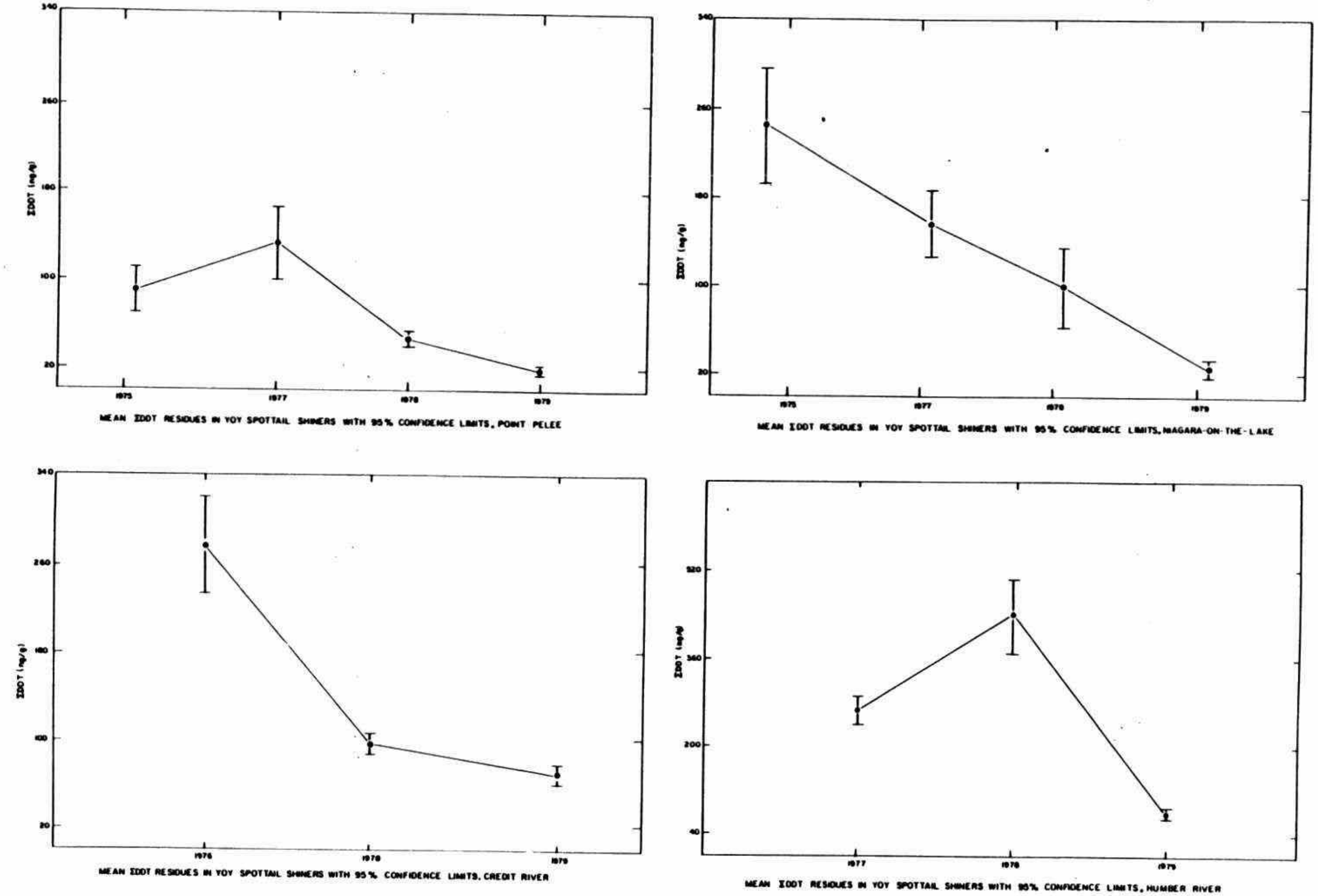

Figure 5: ΣDDT residue trends at Point Pelee, Niagara-on-the-Lake, Credit River and Humber River.

Table 2: Current (1979) Organochlorine Residues in Great Lakes Young-of-the-year Spottail Shiners - 1979 (concentrations in ng/g wet weight).

Sampling Site		Site No.	No. of Samples	Total Length (mm)	% Fat	PCB	ΣDDT	Mirex
Thunder Bay	- Lake Superior	1	6	30 ± 4	2.0 ± 0.6	21 ± 14	10 ± 6	N.D.
Nipigon Bay	"	2	8	32 ± 4	3.5 ± 0.4	22 ± 14	21 ± 13	N.D.
Jackfish Bay	"	3	7	33 ± 4	2.0 ± 0.4	15 ± 11	N.D.	N.D.
Marathon	"	4	8	35 ± 2	2.0 ± 1.2	16 ± 23	2 ± 4	N.D.
Batchawana Bay	"	5	6	35 ± 4	4.0 ± 2.1	N.D.	N.D.	N.D.
Little Lake George	- Georgian Bay	6	6	32 ± 6	2.5 ± 0.9	18 ± 15	5 ± 4	N.D.
Blind River	"	7	8	35 ± 5	1.5 ± 1.0	N.D.	1 ± 2	N.D.
French River	"	8	8	34 ± 3	1.1 ± 0.3	N.D.	N.D.	N.D.
Seguin River	"	9	7	43 ± 4	1.1 ± 0.2	N.D.	N.D.	N.D.
Pretty River	"	10	8	38 ± 3	1.2 ± 0.5	59 ± 9	17 ± 14	N.D.
Beaver River	"	11	8	41 ± 5	1.2 ± 0.5	36 ± 5	9 ± 5	N.D.
Ausable River	- Lake Huron	12	4	55 ± 6	2.8 ± 0.4	121 ± 37	59 ± 21	N.D.
Mitchell Bay	- Lake St. Clair	13	7	55 ± 5	1.0 ± 0.2	N.D.	3 ± 1	N.D.
Thames River	"	14	4	70 ± 5	2.4 ± 0.1	23 ± 10	9 ± 5	N.D.
Pike Creek	"	15	4	63 ± 6	2.1 ± 0.5	114 ± 61	43 ± 19	N.D.
Point Pelee	- Lake Erie	16	7	61 ± 4	3.4 ± 0.5	337 ± 79	18 ± 4	N.D.
Kettle Creek	"	17	8	44 ± 7	1.4 ± 0.7	53 ± 31	9 ± 4	N.D.
Port Rowan	"	18	8	71 ± 5	1.9 ± 0.4	30 ± 9	51 ± 19	N.D.
Centre Creek	"	19	5	56 ± 4	3.1 ± 0.1	47 ± 22	23 ± 6	N.D.
Nanticoke Creek	"	20	5	57 ± 5	1.8 ± 0.1	50 ± 8	24 ± 9	N.D.
Grand River	"	21	8	56 ± 7	2.0 ± 0.5	90 ± 40	18 ± 5	N.D.
Thunder Bay	"	22	5	55 ± 7	1.9 ± 0.3	31 ± 12	9 ± 7	N.D.
Queenston	- Niagara River	23	8	49 ± 3	2.2 ± 0.4	100 ± 28	34 ± 9	N.D.
Niagara-on-the-Lake	- Lake Ontario	24	8	50 ± 2	2.4 ± 0.4	153 ± 23	26 ± 9	1 ± 2
Twelvemile Creek	"	25	8	51 ± 4	2.1 ± 0.4	271 ± 49	60 ± 20	N.D.
Bronte Creek	"	26	6	53 ± 3	3.5 ± 0.5	108 ± 48	34 ± 6	N.D.
Credit River	"	27	8	56 ± 3	3.7 ± 0.6	186 ± 20	69 ± 12	N.D.
Humber River	"	28	8	60 ± 6	4.0 ± 1.3	1223 ± 347	74 ± 12	N.D.
Toronto Harbour	"	29	8	46 ± 3	5.1 ± 1.0	423 ± 105	82 ± 17	3 ± 3
Rouge River	"	30	5	45 ± 4	3.2 ± 0.2	82 ± 35	26 ± 13	N.D.
Gages Creek	"	31	3	49 ± 3	6.0 ± 0.1	197 ± 12	43 ± 18	6 ± 1
Presqui'le Bay	"	32	8	49 ± 3	3.4 ± 0.7	122 ± 22	32 ± 10	TR
Outlet Provincial Park	"	33	8	53 ± 3	4.3 ± 1.2	112 ± 32	58 ± 10	10 ± 3
Macdonnel Island	- St. Lawrence	34	6	49 ± 5	1.4 ± 0.6	N.D.	79 ± 20	N.D.
Cornwall	"	35	3	50 ± 3	3.6 ± 1.2	243 ± 31	62 ± 14	7 ± 1
Grass River (U.S.)	"	36	7	51 ± 2	1.9 ± 0.4	2072 ± 187	95 ± 14	TR
Raquette River (U.S.)	"	37	7	50 ± 2	2.1 ± 0.5	377 ± 81	92 ± 25	6 ± 4

the observed mirex declines in Lake Ontario herring gull eggs (Weseloh et al. 1979).

Other Pesticides

Chlordane residues in young-of-the-year spottails were found in the majority of the collections analyzed (72%). The highest chlordane residues in spottail shiners have been associated with the urbanized regions of the Great Lakes, whereas fish residue levels from predominantly agricultural areas have remained low. The elevated chlordane residues in fish from urbanized watersheds may be indicative of continued chlordane use for commercial pest-control and general household applications.

While I.J.C. Wildlife Protection Guidelines for chlordane were not available for spottail residue evaluation, the highest estimated chlordane concentrations in water (0.01 μg/L) were well below the proposed U.S. and Canadian Drinking Water Standard of 3 μg/L (E.P.A. - 1979). Chlordane concentrations in water were derived from spottail residue data by applying a fish concentration factor of 5500 (E.P.A. - 1979) to the greatest body burden level measured in the 1979 survey of 47 ng/g at the Humber River.

Residue levels for HCB, BHC, lindane, heptachlor, aldrin, dieldrin, thiodan and endrin have been low in all of the Great Lakes spottail shiner collections. Typically fish residue values for these chemicals have remained near their detection limits.

SUMMARY AND CONCLUSIONS

The results of the nearshore fish contaminant surveillance have demonstrated that significant PCB, DDT and mirex residue reductions have occurred in young-of-the-year spottail shiners of the Lower Great Lakes.

Recent usage restrictions for PCBs, DDT and mirex are well documented, however, quantitative data for changes in contaminant loadings to the receiving waters generally are not available. It is therefore encouraging to note that contaminant accumulations in nearshore fishes have responded favourably to the control measures implemented, and it appears that use and discharge regulations can play a major role in restricting environmental contaminants.

While the observed residue trend data for nearshore spottail shiners cannot be used quantitatively to predict residue changes in adult fishes of the Great Lakes, a general contaminant residue decline is to be expected if present trends are maintained.

Although the residue declines for some of the principal Great Lakes fish contaminants suggest improved water quality, these observations have to be restricted to the specific contaminant objectives investigated. Given the multitude of persistent toxicants in the Great Lakes, human and environmental health evaluations can only be based on the integrated effects of all the toxicants and their interactions with other environmental factors.

Future activities of the nearshore fish contaminants program will be expanded to include other chlorinated compounds with bioaccumulative characteristics.

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APPENDIX 1

SITE IDENTIFICATIONS FOR SPOTTAIL SHINER COLLECTIONS

Sampling Site		Site No.	
Thunder Bay	- L. Superior	1	Mission River delta
Nipigon Bay	- " "	2	Ozone Creek delta
Jackfish Bay	- " "	3	Eastshore Jackfish Bay
Marathon	- " "	4	Little Black River
Batchawana Bay	- " "	5	Batchawana River delta
Little Lake George	- Georgian Bay	6	Garden River delta
Blind River	- " "	7	New Blind River channel delta
French River	- " "	8	Main French River delta
Seguin River	- " "	9	Seguin River delta
Pretty River	- " "	10	Pretty River delta
Beaver River	- " "	11	Beaver River delta
Ausable River	- L. Huron	12	South side of harbour
Mitchell Bay	- L. St. Clair	13	Beach north of harbour
Thames River	- " "	14	Thames River delta
Pike Creek	- " "	15	St. Clair Beach
Point Pelee	- L. Erie	16	Leamington beach at pier
Kettle Creek	- "	17	Beach east of harbour
Port Rowan	- "	18	East of pier at Port Rowan
Centre Creek	- "	19	Centre creek delta
Nanticoke Creek	- "	20	Nanticoke creek delta
Grand River	- "	21	Beach east of harbour
Thunder Bay	- "	22	Beach at Bernard St.
Queenston	- Niagara River	23	Downstream from Queenston ≈0.5 km

Niagara-on-the-Lake	- L. Ontario	24	East of Canada Customs
Twelve Mile Creek	- " "	25	West side of pier
Bronte Creek	- " "	26	East side of pier
Credit River	- " "	27	J. Darling park, west of river
Humber River	- " "	28	Humber delta, east side
Toronto Harbour	- " "	29	Olympic island, north side
Rouge River	- " "	30	Rouge delta
Gages Creek	- " "	31	Gages Creek delta
Presqui'le Bay	- " "	32	Outer bay facing west
Outlet Prov. Park	- " "	33	Main beach area
Macdonnel Island		34	East beach area
Cornwall		35	Inlet just below International bridge
Grass River (U.S.)		36	Grass River delta, east shore
Raquette River (U.S.)		37	Raquette delta, east shore

Appendix 2 Organochlorine residues in Great Lakes young-of-the-year spottail shiners (concentrations in ng/g wet weight)

Sampling Site		Site No.	No. of Samples	Total Length (mm)	% Fat	PCB	DDT	Mirex	HCB	Lindane	BHC		Chlordane	
											α	β	α	γ
Thunder Bay	- Lake Superior	1	8	30 ± 4	2.0 ± 0.6	21 ± 14	10 ± 6	N.D.	N.D.	N.D.	N.D.	N.D.	3 ± 1	1 ± 1
Nipigon Bay	"	2	8	32 ± 4	3.5 ± 0.4	22 ± 14	21 ± 13	N.D.	N.D.	N.D.	N.D.	N.D.	3 ± 1	5 ± 3
Jackfish Bay	"	3	7	33 ± 4	2.0 ± 0.4	15 ± 11	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Marathon	"	4	8	35 ± 2	2.0 ± 1.2	16 ± 23	2 ± 4	N.D.	N.D.	N.D.	N.D.	N.D.	2 ± 1	1 ± 1
Batchawana Bay	"	5	6	35 ± 4	4.0 ± 2.1	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Little Lake George-Georgian Bay		6	6	32 ± 6	2.5 ± 0.9	18 ± 15	5 ± 4	N.D.	N.D.	N.D.	1 ± 1	3 ± 3	2 ± 1	1 ± 1
Blind River	"	7	8	35 ± 5	1.5 ± 1.0	N.D.	1 ± 2	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
French River	"	8	8	34 ± 3	1.1 ± 0.3	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Seguin River	"	9	7	43 ± 4	1.1 ± 0.2	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Pretty River	"	10	8	38 ± 3	1.2 ± 0.5	59 ± 9	17 ± 14	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Beaver River	"	11	8	41 ± 5	1.2 ± 0.5	36 ± 5	9 ± 5	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.
Ausable River	- Lake Huron	12	4	55 ± 6	2.8 ± 0.4	121 ± 37	59 ± 21	N.D.	1 ± 1	N.D.	2 ± 1	N.D.	8 ± 2	11 ± 3
Mitchell Bay	- Lake St. Clair	13	7	55 ± 5	1.0 ± 0.2	N.D.	3 ± 1	N.D.	N.D.	N.D.	1 ± 1	N.D.	2 ± 1	1 ± 1
Thames River	"	14	4	70 ± 5	2.4 ± 0.1	23 ± 10	9 ± 5	N.D.	N.D.	N.D.	5 ± 0	N.D.	6 ± 3	5 ± 4
Pike Creek	"	15	4	63 ± 6	2.1 ± 0.5	114 ± 61	43 ± 19	N.D.	5 ± 4	N.D.	1 ± 3	N.D.	6 ± 3	4 ± 3
Point Pelee	- Lake Erie	16	7	61 ± 4	3.4 ± 0.5	337 ± 79	18 ± 4	N.D.	1 ± 1	TR	2 ± 1	N.D.	9 ± 3	4 ± 3
Kettle Creek	"	17	8	44 ± 7	1.4 ± 0.7	53 ± 31	9 ± 4	N.D.	N.D.	N.D.	N.D.	N.D.	3 ± 1	2 ± 2
Port Rowan	"	18	8	71 ± 5	1.9 ± 0.4	30 ± 9	51 ± 19	N.D.	N.D.	N.D.	TR	N.D.	11 ± 2	12 ± 3
Centre Creek	"	19	5	56 ± 4	3.1 ± 0.1	47 ± 22	23 ± 6	N.D.	N.D.	N.D.	2 ± 1	N.D.	4 ± 2	N.D.
Nanticoke Creek	"	20	5	57 ± 5	1.8 ± 0.1	50 ± 8	24 ± 9	N.D.	N.D.	N.D.	N.D.	N.D.	3 ± 2	4 ± 2
Grand River	"	21	8	56 ± 7	2.0 ± 0.5	90 ± 40	18 ± 5	N.D.	N.D.	3 ± 3	N.D.	N.D.	3 ± 3	N.D.
Thunder Bay	"	22	5	55 ± 7	1.9 ± 0.3	31 ± 12	9 ± 7	N.D.	N.D.	N.D.	N.D.	N.D.	4 ± 2	5 ± 0
Queenston	- Niagara River	23	8	49 ± 3	2.2 ± 0.4	108 ± 28	34 ± 9	N.D.	6 ± 3	TR	4 ± 4	N.D.	11 ± 3	10 ± 3
Niagara-on-the-lake	- Lake Ontario	24	8	50 ± 2	2.4 ± 0.4	153 ± 23	26 ± 9	1 ± 2	4 ± 1	N.D.	N.D.	N.D.	12 ± 10	9 ± 8
Twelvemile Creek	"	25	8	51 ± 4	2.1 ± 0.4	271 ± 49	60 ± 20	N.D.	TR	TR	2 ± 1	N.D.	N.D.	N.D.
Bronte Creek	"	26	8	53 ± 3	3.5 ± 0.5	188 ± 48	34 ± 6	N.D.	N.D.	N.D.	3 ± 2	N.D.	8 ± 2	11 ± 2
Credit River	"	27	8	56 ± 3	3.7 ± 0.6	186 ± 28	69 ± 12	N.D.	N.D.	TR	7 ± 3	N.D.	18 ± 4	18 ± 3
Humber River	"	28	8	60 ± 6	4.0 ± 1.3	1223 ± 347	74 ± 12	N.D.	3 ± 1	1 ± 1	2 ± 2	N.D.	31 ± 6	16 ± 4
Toronto Harbour	"	29	8	46 ± 3	5.1 ± 1.0	423 ± 105	82 ± 17	3 ± 3	1 ± 1	2 ± 0	1 ± 1	11 ± 2	15 ± 2	N.D.
Rouge River	"	30	5	45 ± 4	3.2 ± 0.2	82 ± 35	26 ± 13	N.D.	TR	1 ± 0	6 ± 2	N.D.	3 ± 4	1 ± 1
Gages Creek	"	31	3	49 ± 3	6.0 ± 0.1	197 ± 12	43 ± 18	6 ± 1	1 ± 1	2 ± 0	7 ± 1	N.D.	10 ± 1	10 ± 1
Presqui'le Bay	"	32	8	49 ± 3	3.4 ± 0.7	122 ± 22	32 ± 10	TR	TR	N.D.	N.D.	N.D.	5 ± 3	3 ± 3
Outlet Provincial Park	"	33	8	53 ± 3	4.3 ± 1.2	112 ± 32	58 ± 10	10 ± 3	1 ± 1	2 ± 2	10 ± 5	N.D.	20 ± 5	17 ± 3
Macdonnel Island	- St. Lawrence	34	8	49 ± 5	1.4 ± 0.6	N.D.	79 ± 20	N.D.	N.D.	N.D.	N.D.	N.D.	8 ± 2	N.D.
Cornwall	"	35	3	50 ± 3	3.6 ± 1.2	243 ± 31	62 ± 14	7 ± 1	3 ± 1	1 ± 1	4 ± 2	2 ± 1	7 ± 4	N.D.
Grass River (U.S.)	"	36	7	51 ± 2	1.9 ± 0.4	2072 ± 187	95 ± 14	TR	N.D.	1 ± 1	1 ± 1	1 ± 1	16 ± 10	1 ± 2
Raquette River (U.S.)	"	37	7	50 ± 2	2.1 ± 0.5	377 ± 81	92 ± 25	6 ± 4	N.D.	1 ± 1	3 ± 2	1 ± 1	20 ± 9	TR
Detection Limits						20	5	5	1	1	1	1	1	1

N.D. - Non-Detectable

TR. - Trace